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Title: Update on Salt Disposal R&D LANL

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Spent Fuel and Waste Science and Technology

Update on Salt Disposal R&D
LANL
WP#SF-18LA01030301

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SFWST Annual Working Group Meeting

University of Las Vegas

May 23, 2018

LA-UR-18-nnnnn

Overview of Activity

Examine heat/brine/vapor/salt interactions related to heat generating nuclear waste

- **Improve numerical modeling capabilities (https://fehm.lanl.gov)**
  - Validate reactive transport model functions for salt against all available data
  - Identify any gaps in capabilities
  - Improve existing model functions
- **Design and execute experiments : generate data to compare to simulations**
- **Benchmark with other numerical codes PFLOTRAN/TOUGH3**

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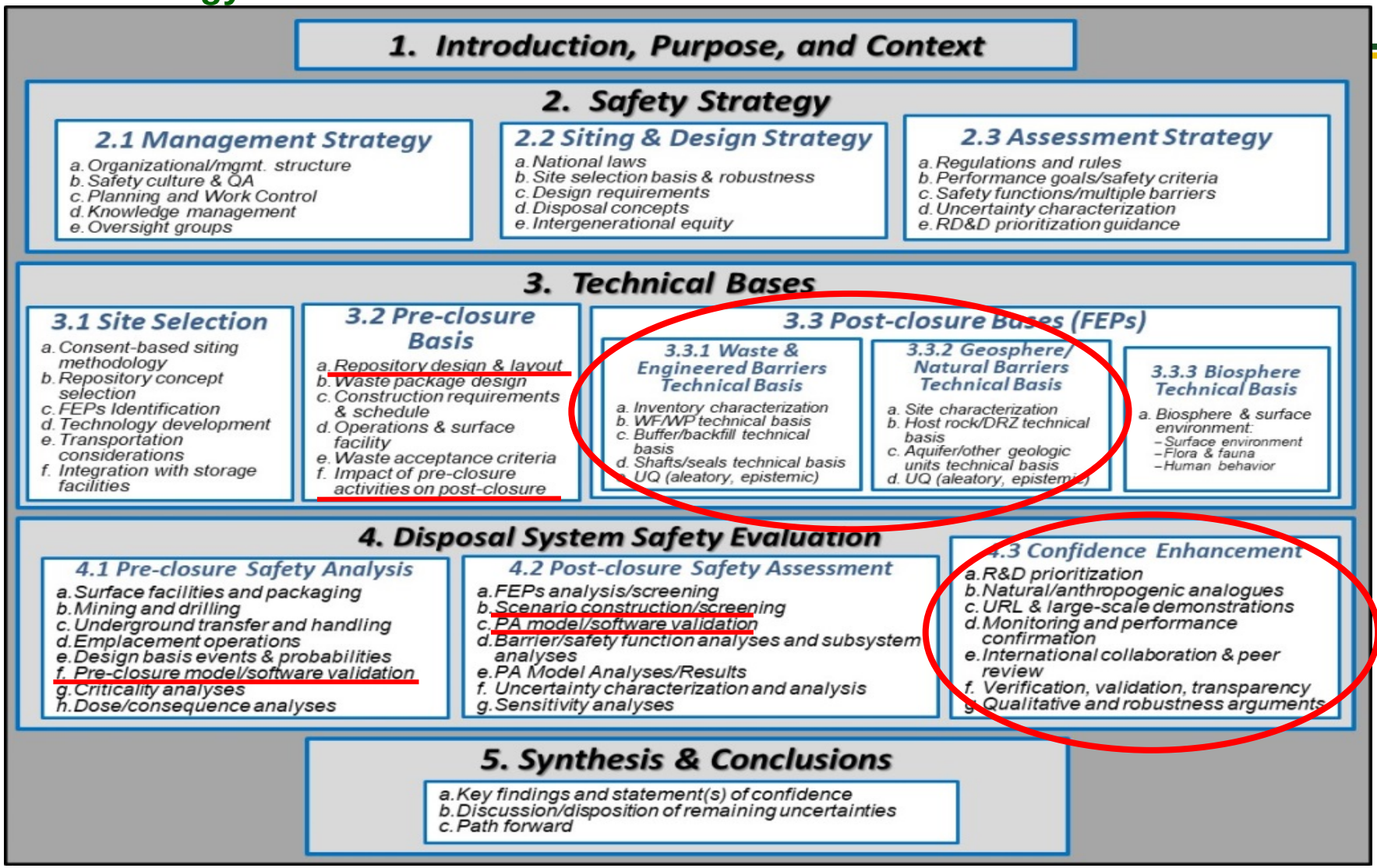
Connection to Bigger Picture



Connection to Bigger Picture

*2. Physical-chemical properties of crushed salt backfill at emplacement
3. Changes in physical-chemical properties of crushed salt backfill after waste emplacement
5. Mechanical response of backfill
6. Impact of mechanical loading on performance of the waste package
7. Brine and vapor movement in the backfill and emplacement drift, including evaporation and condensation
9. Mechanical and chemical degradation of the waste forms
11. Changes in chemical characteristics of brine in the waste package
12. Radionuclide solubility in the waste package and EBS
14. Stratigraphy and physical-chemical properties of host rock
15. Changes in physical-chemical properties of host rock due to excavation, thermal, hydrological, and chemical effects
16. Mechanical response of host rock due to excavation (e.g., roof collapse, creep, drift deformation)
17. The formation and evolution of the DRZ
18. Brine and vapor movement through the host rock and DRZ, including evaporation and condensation
23. Thermal response of EBS and geosphere (heat transfer from waste and waste packages into the EBS and geosphere)
*25. Gas generation and potential physical impacts to backfill, DRZ, and host rock
27. Colloid formation and transport in the waste package, EBS, and host rock (including DRZ)
28. Performance of seal system
31. Appropriate constitutive models (e.g., darcy flow, effective stress)
32. Appropriate representation of coupled processes in process models
33. Appropriate representation of coupled processes in total system performance assessment (TSPA) models
34. Appropriate inclusion and scaling/representation of spatially and temporally varying processes and features in process and TSPA models
37. (Modeling) verification and validation
38. (Modeling) data and results management
39. Development of accurate instrumentation and methods for in-situ testing and characterization
40. In situ demonstration and verification of repository design, with respect to impact on the host rock and the ability to comply with pre-closure and post-closure safety requirements
41. Demonstrate under representative conditions the integrated design functions of the waste package, backfill, host rock, and ventilation
42. Provide a full-scale benchmark for understanding coupled THMC processes and comparing measured system responses with model predictions and assumptions
43. (Confidence-building) Develop generic safety case
44. (Confidence-building) Comparisons to natural and anthropogenic analogs
*45. (Confidence-building) International collaboration
46. (Confidence-building) In-situ testing and demonstrations
47. (Confidence-building) Verification, validation, transparency, and traceability

High Priority FEPS

Stauffer et al. 2015, UFD-2015-000077, modified from Sevougian et al. 2013

R&D prioritization

High Priority FEPs from scoping workshop for Salt

Evolution of backfill

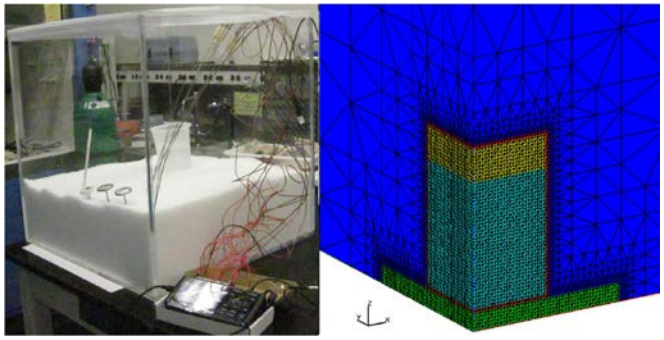
Strong feedback of water on consolidation

Dehydration of ubiquitous impurities

Generation of acid vapors (HCl)

Experimental success I

Salt box

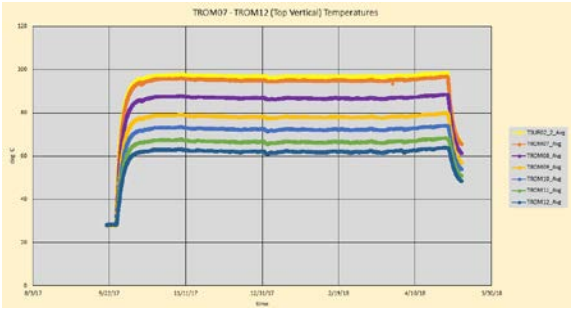


Fluid inclusions

WIPP Salt cone

Acid gas generation

WIPP canister thermal data



Experimental success II
Field Test – WIPP Heated Borehole

In progress

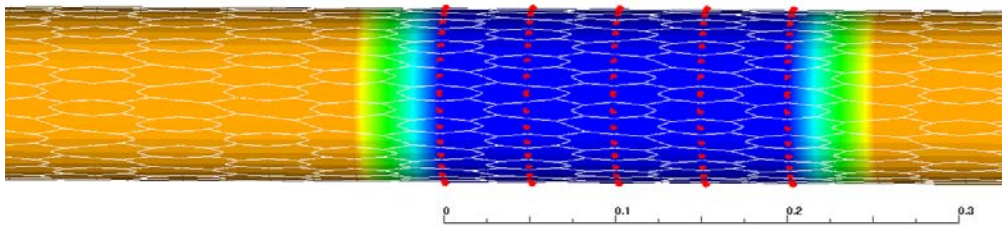
Feb 2018 Packer holes pressure in the hole

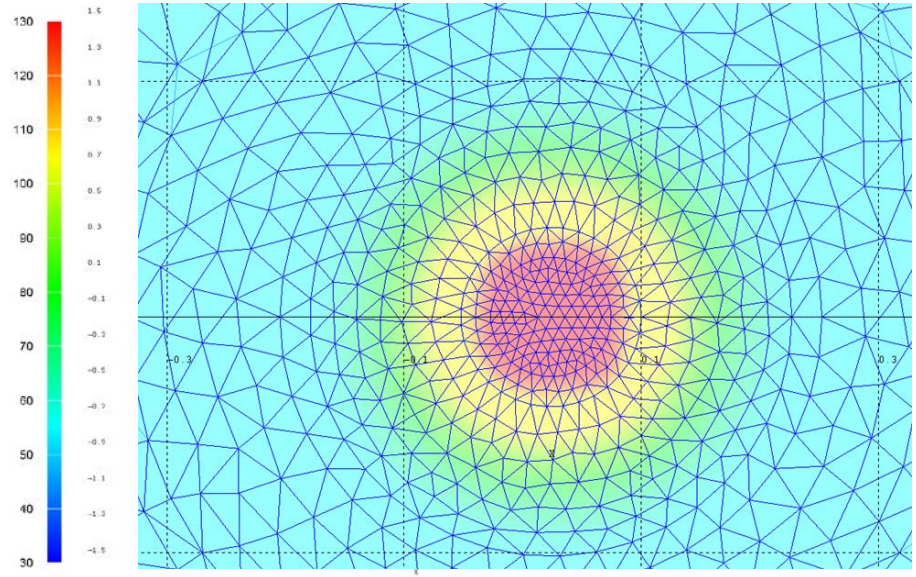
Gas/vapor sampling tested

Nitrogen hooked up safely

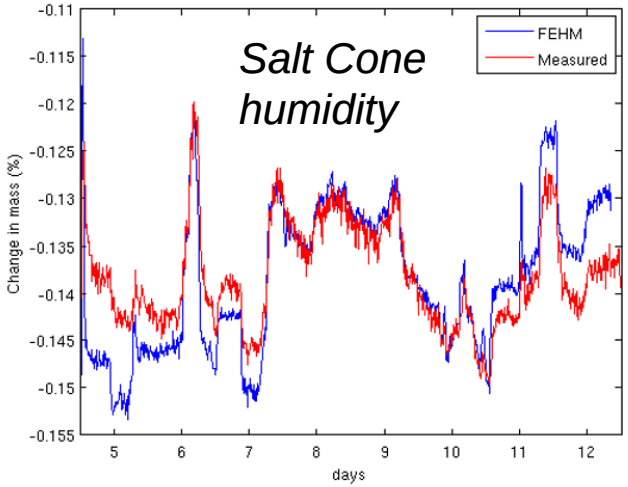
May 2018 thermal data

Modeling success





Predicted temperature profiles for WIPP borehole test



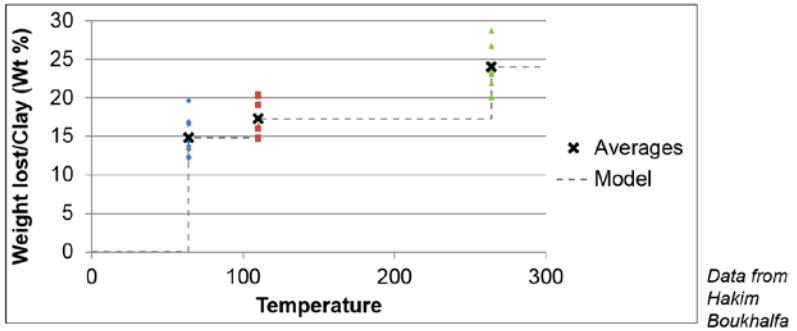
Mass change (%) of salt cone, showing comparison of FEHM model results (blue) to lab measurements (red).

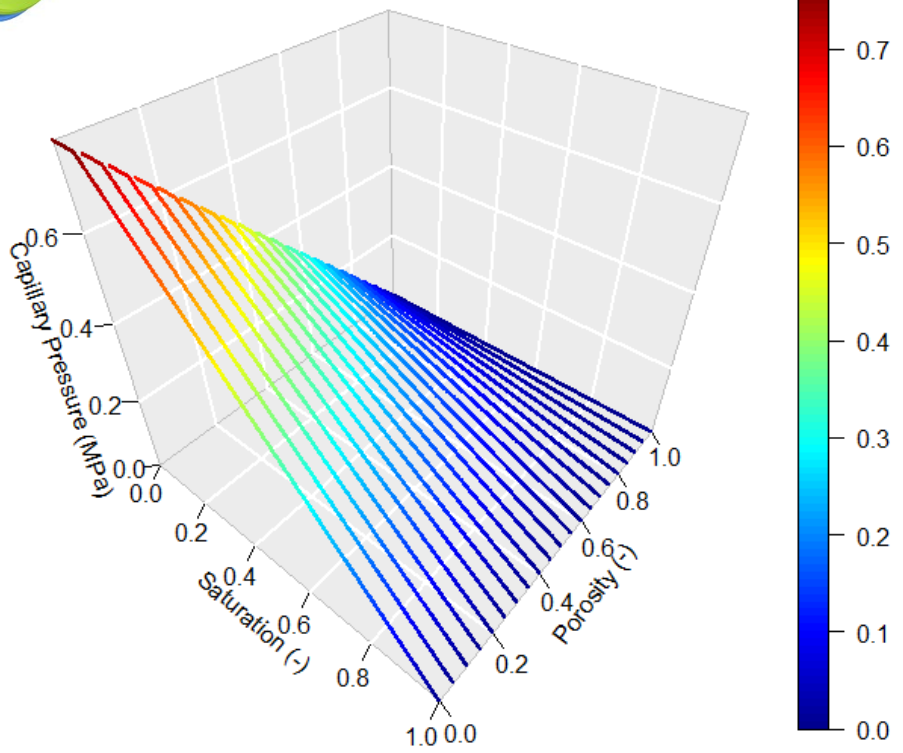
New Salt Functions in FEHM

Changes in porosity lead to changes in:
- *permeability*
- *thermal conductivity and heat capacity*
- *vapor diffusion coefficient*

Changes in temperature lead to changes in:
- *thermal conductivity*
- *salt solubility*
- *water vapor pressure*
- *brine viscosity*

Clay dehydration algorithm based on laboratory data



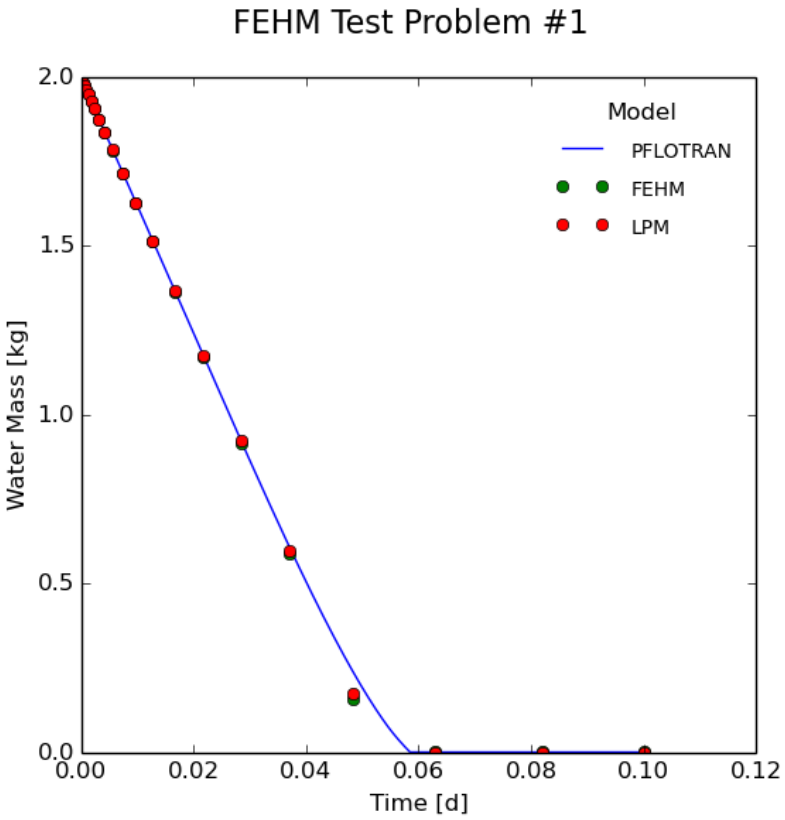


3-D capillary function

Integration progress

- *LANL and SNL working to add capability to PFLOTRAN based on FEHM experience with code validation tests*

- *Given a constant flow rate we compared the FEHM solution to an analytical solution for water removal using the holding capacity of 20°C air and the air-flow rate*
- *FEHM and PFLOTRAN successfully dry out the matrix water and remove the water in vapor form*



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Future R&D & Integration Timeframe

- **Lab and Field results have yielded valuable data – these will guide further R&D efforts for high priority FEPs**

- **Confirming processes and parameters and working to feed results back to PA tools. – ongoing.**
  - Work with SNL to embed new physics into PFLOTRAN continues.
  - Having a dedicated PostDoc or early career staff member on this would help greatly speed up this task.

- **Ensure constancy between DOE simulation tools for the same test cases**
  - This could be tasked in the next year or two.
  - Base test cases on thought experiments and/or proven laboratory data.